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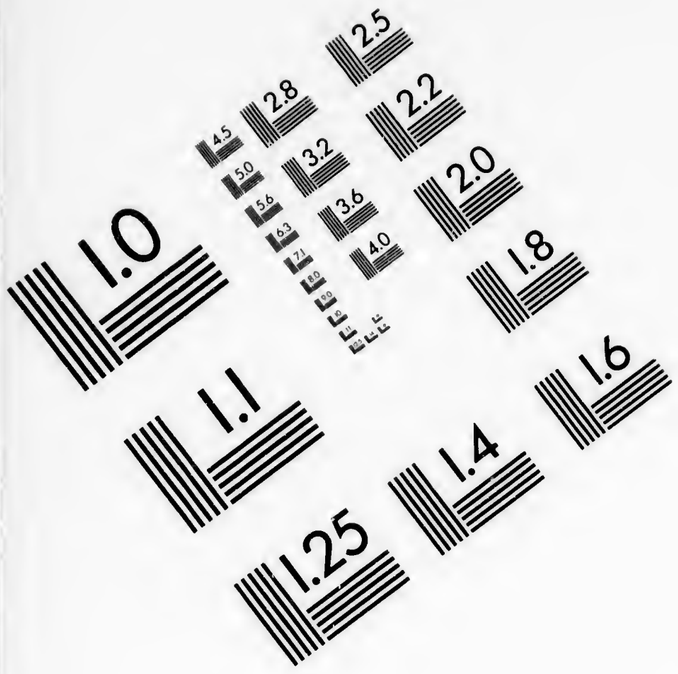

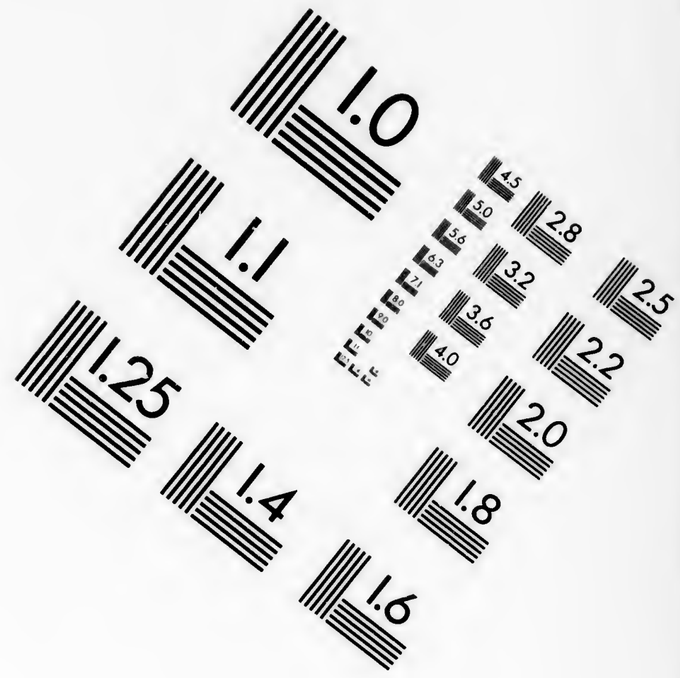

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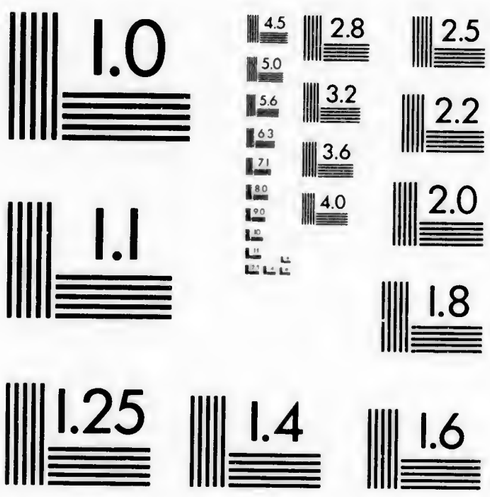

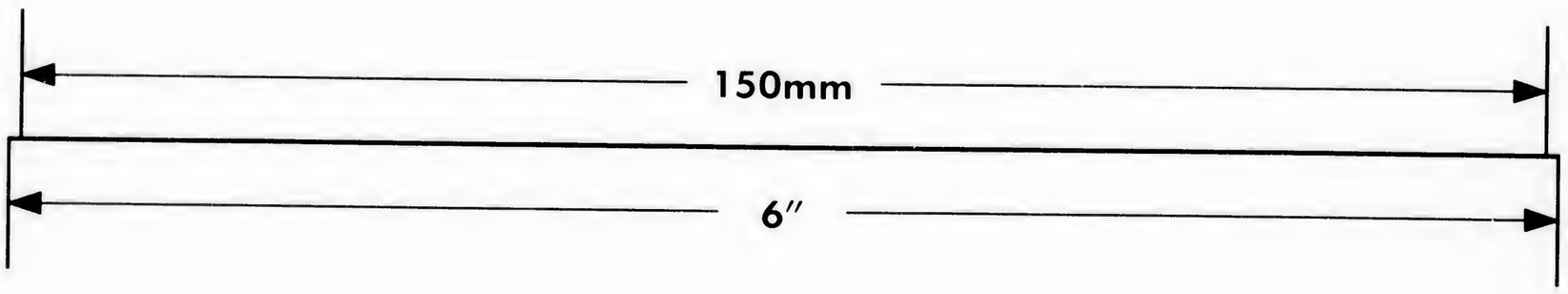

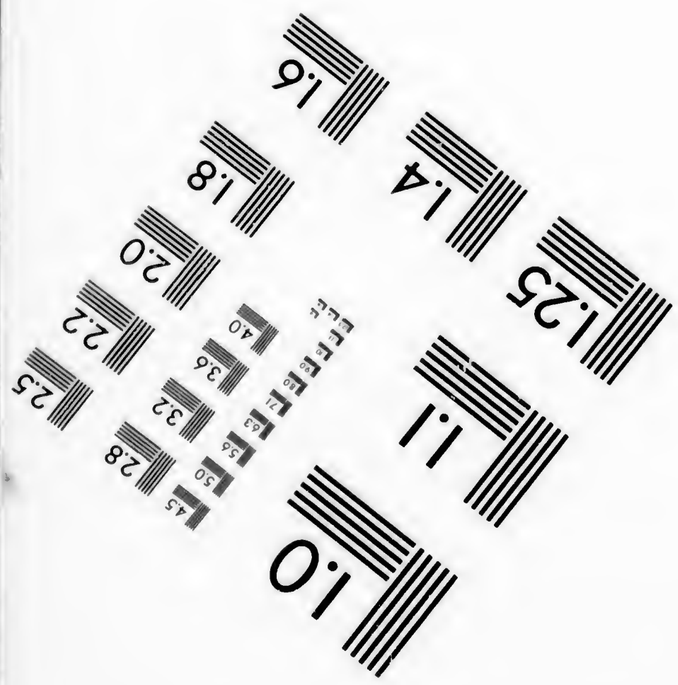

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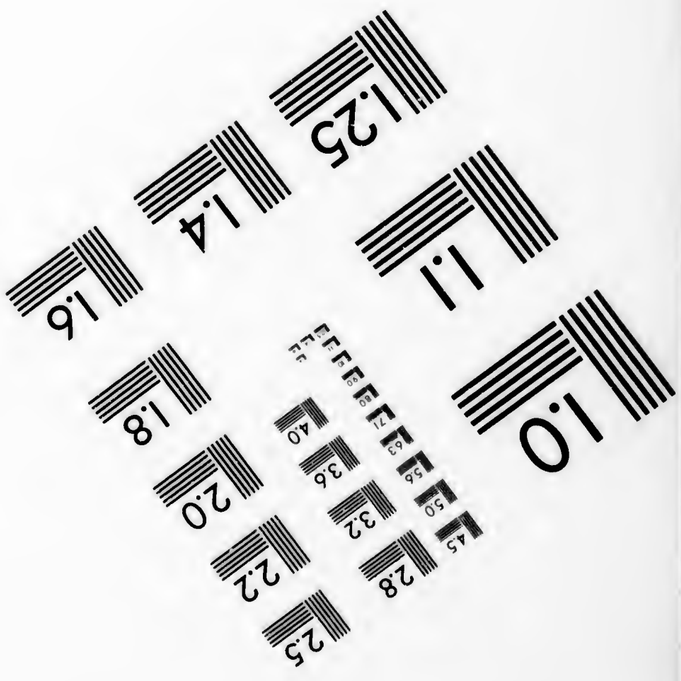

THE PENNSYLVANIA STATE COLLEGE
SCHOOL OF AGRICULTURE AND EXPERIMENT STATION

Department of Agronomy

A Monograph On The Potato

by

G. W. Cochran

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Approved Feb. 18 1918.

By Frank D. Gardner

Professor of Agronomy.

THE POTATO

Of the three purely American plants, corn, tobacco and the potato, occupying a prominent place among our American agriculture, it is possible that the potato finds a place in the regular diet in more homes than corn, and is certainly of more economic importance than tobacco. The potato, so far as is now known, is a native of South America. Spanish explorers of the sixteenth century, reported it as a food product used by the natives of what is now Chile and Peru.

Its native home has an altitude of from three to six thousand feet. In Colorado today, it seems to do well at this altitude. Just how it came to be grown in what is now the U.S., is more or less of a mystery. However, certain writers seem to have the opinion that the Spaniards probably carried it to Florida, from whence it found its way to Virginia. From the new world, it was carried to England through the stimulus of prizes that England was offering for new and valuable plants. The colonists reported it as growing in Virginia, no larger than a marble. While there is some disagreement as to who took it to England, whether Sir Walter Raleigh or Sir Francis Drake, yet most authorities agree as to the year of its introduction into England, that it came from Virginia and that it was first planted near Cork, Ireland, and perhaps gets its name, "Irish Potato," from the above-mentioned fact.

It was with the potato as with most new plants or fruits. The public must become acquainted with them, be convinced of their value and perhaps even cultivate a taste for them. However, in 1663, through the office of the Royal Society, the food value

of the potato was shown and as a consequence, its culture became quite general. It took a panic in Scotland to show the people the value of it. This occurred in the middle of the eighteenth century. In America, it was received fairly well, for it is reported at about the time of the panic in Scotland that 700 bushels were imported from South Carolina. Italy appears to have given attention to it before any other European country. Following Italy, these other European countries in the order which follows, took up its cultivation: Switzerland, France, Germany, Russia, and then China in the Orient.

Perhaps more credit belongs to M. Parmentier for spreading the gospel of the virtues of the potato, than to any other one man. Louis XVI did some good work along the same line by ordering a large tract planted to potatoes. The king ordered this plot guarded, and this aroused curiosity, and hence stimulated interest in the plant.

The first U.S. census reporting the potato crop was in 1840. The crop is given as 108,298,060 bu. Today, in 1917, it is one of the most important articles of food.

BOTANY OF THE POTATO

The potato belongs to the night shade family, which explains to those acquainted with the family, why practically all persons in time gone by, were prejudiced against the potato.In the above mentioned family, are found the tobacco, tomato, egg plant and capsicum. There are, in all, 1,600 species, of which only six bear tubers.

The wild potato produces seed from the flowers. While

certain varieties still produce seed balls, yet it is by no means common as it was thirty or forty years ago.

From the classification of the botanist, the potato is known as solanum tuberosum. The genus solanum carries with it, the meaning of sleep or soothing, while the species tuberosum suggests the meaning of swelling. Hence, the thot is a soothing plant with swellings.

About 1590, Jaspard Bonhim, a botanist of Basle, Swtitzerland, gave it its name. The Indians called it Openank, while a Frenchman gave it the popular name, potato. It had been called Pomme de Terre. Potato seems to have been a corruption of the Indian name, "papas" meaning roots, and "bata", Virginiata.

The potato is a wide feeder, and may cover as much as 9 feet yet until the plant is established it is a weak feeder and needs special care if it is to start at once to grow.

SOILS FOR POTATOES.

If the question,"What is the best soil for potatoes", were put to a number of potato growers, it is likely there would be a diversity of opinion. Each grower may feel that he has the soil best suited for the crops. In the writer's brief experience he has met men who are well known potato growers. Since his interests ran along the line of growing potatoes, naturally the conversation ran in that line. In Michigan the growers feel that their soils, clay loam, or sandy loam is best for potatoes, for quality as well as quantity. In Minnesota the ideal soil may be different. The writer has seen as many as 446 bushels grown on an acre of clay soil in northern Minnesota. As a rule, perhaps, the grower who understands his respective soil can and does cater to its peculiarities, makes his success not because he has a clay loam, but because he understands

and has mastered his own problem.

There are a number of things that all potato growers realize must be present, if there is to be a good crop of potatoes. These are: a fertile soil, good soil texture, and good drainage. Soil fertility does not necessarily mean that the soil must contain a large amount of plant food, but rather the plant food, assuming there is enough there, must be in a form that is available. We are told that most soils contain sufficient plant food for 100 crops, of 200 bushels of potatoes per acre, however, the sixty or eighty bushel crops per acre is all too common. There then seems to be two conditions to meet. The first is to supply plant food when it is really deficient, while the second one is to make the unavailable, available. How shall this be done? Too often it is hoped to be reach ed thru the commercial fertilizer. The writer appreciates that a complete fertilizer is a mighty good thing and besides the market gardner would find his burdensmore onerous than they are, were it not for commercial fertilizers. However, many a dollar has been spent for fertilizer, for which the grower has never realized 50% of the amount invested.

Why is this? The real reason is that using commercial fertilizer is almost a profession in itself. No amount of commercial fertilizer will ever take the place or do the work that must be done by and thru proper preparation of the soil, cultivation and other means required by the potato. It is a well known fact that all plant food taken up by the roots of the plant must be taken up as a solution. This means that there must be plenty of water. Then besides how unwise it is to supply the roots with plenty of available food, and yet allow insects or other causes to so defoliate the plant that there is no balance between the root and the plant. Certainly

the leaves are as important as the roots. Id the foregoing considerations have been cared for then a supply of fertilizer might be made to return a fair rate of interest on the money invested.

It was thot, and still is by some that the idea is to add to the soil an equal amount of plant food, that the crop took from the soil. This naturally seems to be correct. It is not, for no account is made of available plant food in the soil or the amount of food taken from the air. It is fair to suppose that a muck soil needs more potash than one in which potash is abundant. Then too, a soil in good physical condition, containing plenty of humus, tending to supply nitrogen, and to help retain moisture, as well as make available mineral plant food, will require a smaller amount of applied fertilizer than will one lacking these. It seems fair to ask the grower whether he really knows the soil upon which he hopes to grow or is growing potatoes.

It is known that a yield of 100 bushels of potatoes will remove from the soil approximately 31.5 lbs of nitrogen, 13.5 lbs. phosphoric acid, and 45 lbs. of potash, from the soil. Accordingly the fertilizers were up to a year or so ago, made of a goodly amount of nitrogen, a fair amount of phosphoric acid and a large quantity of potash, forgetting or ignoring the character of the soil, and paying no attention to the known effect of phosphoric acid an all crops. It seems only reasonable to say that much money has been wasted on commercial fertilizer made after the foregoing discussion.

It is generally accepted that nitrogen produces growth, and foliage and is evidenced by a dark rich color. If nitrogen is lacking a weak growth and yellow color is the result.

Phosphoric acid influences the production of seed, hastens the maturity of the crop and is supposed to influence the formation of starch. Potash is supposed to make strong stalks and be important

for the plant's developing starch. While a certain amount of all elements of plant food is necessary for the proper functioning of the plant, yet it is easily seen how a preponderence of one element can be a detriment to the plant. For instance, let us suppose there is an excess of nitrogen early in the season. In case drought should follow as is often the case, the roots are called upon to pump a large amount of water from the soil. In case the water is not to be had, the plant must suffer, and of course the crop is short. Then too, where there is a rank growth, the foliage is more tender, and hence less able to resist desease.

From an example on Long Island it was found that no potash gave a poor yield while four per cent gave a good yield. At the same time seven percent gave a better return than four percent, and ten per cent better than seven percent, yet neither the seven percent nor the ten percent made enough difference to pay for the extra cost of the potash.

In considering fertilizers we must not forget the value of stable manure. It is true from a monetary value of plant food in manure it is often found that the same amount of plant food can be gotten cheaper and as available in commercial fertilizers, yet the real value of manure is not only in the amount of plant food it contains, but often as much or more value comes from the effect it has on the physical nature of the soil.

Lime is not needed as a plant food and it may even prove deleterious, for it may make the soil better suited for the growth and development of scab. When lime is necessary for clover, then the lime should be applied following the potato crops, applying about depending on the acidity of the land.
500 lbs. caustic lime to the acre/ If a formula were needed for general purposes a 4-10-5 fertilizer may answer as well as any. In

to have a good deep soil, and when it can be done, subsoiling may help a good deal in producing a good crop of potatoes. The excess water must be taken off, for it will allow the soil to warm earlier in the spring and at the same time increase the water holding power of the soil.

applying a nitrate, it is best sometimes to apply half the amount at the beginning of the season and later in the summer apply some more. It is generally cheaper and better to supply the nitrogen by growing leguminous crops. From a table the following is secured:-

Fert. in Lbs.	Cost	Inc. yield	Money gain
500	$6.25	23.3	$5.40
1000	12.50	44.3	10.60
1500	18.75	55.4	8.97
2000	25.00	61.4	5.70

While considerable space has been given to the fertilizers of potatoes, yet the soil texture may be as important as the fertilizer. It is certainly true that the soil that does not possess a good texture is by no means fit for the time being for a good potato seed bed. The soil must be easily worked, it must be so that it can be worked soon after a rain and yet not bake nor puddle. The soil must be heavy enough to retain humus and also moisture. Where a soil is inclined to be heavy it may be made into a good potato soil by plowing under crops of clover, peas, etc.

Very often a surface soil is as good as desired yet if the subsoil is so that the water does not sink into it, then drainage must be resorted to. It is a good plan.

PREPARATION OF SEED BED.

In preparing a field for potatoes, it has been the writer's experience, even tho he has not grown them on a commercial scale, that the best seed bed is the one prepared the year before the crop is to be planted. In case there is a rotation carried out upon the farm, it is generally true that the work will be so handled that the potato field will be in good condition for the crop. While fall or spring plowing is best as certain conditions prevail, however fall

plowing should be recommended as the rule and spring plowing as the exception. If a field that is in clover is to be planted to potatoes the following year, it should be plowed reasonably early in the fall and the furrows left on edge rather than turned flat, as is often done, with a plow similar to the breaking plow. Then in the Spring it can be worked earlier, and put in good tilth. The amount of work required will depend on the nature of the soil, whether the field had a tough sod on it, and the tools used. In case a sod is to be plowed for a crop of potatoes the next year, it is far better to double disc the sod before plowing. Then in the spring the soil should be worked enough so that a good connection will be made between the surface soil and the subsoil, in order thatthe water will be able to come to the roots of the plant.

When all that has been mentioned has been done, it is a good plan, if time will permit, to allow the field to lie a week before planting. This will allow a crop of weeds to start which can easily be killed with a light harrow, or a weeder in case the land is not rough or stony. In case the planting is then done, a second harrowing after the crop is planted will get a second crop of weeds and do no harm to the potatoes but instead will sometimes break a crust that has formed upon the surface of the soil, and allow the potato to get ahead of the weeds that follow.

TIME OF PLANTING.

The time of planting must be determined by the climate of the locality and by the use to which the crop is to be put. The great bulk of potatoes are grown to be used from fall 'till spring and hence the real early crop is important only in certain districts as in parts of Maryland, and on Long Island. When the crop of potatoes are planted so that the tubers are just forming when there is

an exceeding high temperature, the result is somewhat fatal to the crop. The potato is forming or setting just when the flowers are for ming, so that the plant is taxed to the limit.

DEPTH OF PLANTING.

The depth to plant the potato depends on local conditions, hence no general rule can be given unless certain conditions prevail. If the soil is heavy, then the potato must not be planted so deeply, for it requires a certain soil temperature before the potato will start. At the same time in case the soil is light and the potato is cover-ed so shallow that the required moisture is not present then the potato will not sprout. Where we have a fairly heavy soil the depth should be about two inches. Three inches is not too deep in case the soil is light. It not infrequently happens that the soil over the potato is so light, and so dry that there is not capillary attraction between the lower particles and the upper ones. In this case a light roller may put the soil in such condition that capillary attraction may be established between the soil particles.

There are persons who plow a furrow and then drop a row of potatoes and then plow two furrows and drop another row. It is true that fair crops are sometimes grown this way, but it is in spite of the preparation instead of on account of the preparation. To say the least such practices show poor husbandry, and should not be encour aged.

MANNER OF PLANTING.

Just how is the best manner of planting potatoes? One grower believs that pieces placed at a distance of two feet apart in the row with the rows three feet apart will give the best results, another grower will urge planting in a check system, while a third will contend that pieces placed 14" apart and the rows 3 feet apart

between the rows will give the best results. Perhaps each system has its merits and defects. When the land is such that potato machinery can be used, the check system is very satisfactory. If it is a case of keeping the crop clean the above mentioned system is very desirable. However, when the soil is fertile enough to produce a crop of over 100 bushels to the acre, the drill system is more desirable. Nevertheless, the writer has seen 300 bushels produced on land planted according to the check system. There can be nothing said in favor of the hill system except when land will not permit the check system, then by planting two feet apart in the row will permit the crop to be kept clean when hand labor is employed.

SEED.

The question as to whether to plant the whole potato or a piece has been discussed pro and con ever since the potato growing has been an industry. There are those who still claim certain virtues for the whole tuber over the piece. However, there is always the chance of the factors of care, preparation of the soil, and the selection of the seed, any of which may mean more than the difference due to the whole potato or the piece.

From a number of experiment stations the census of opinion seems to be that (Mo. Bul. 33) the whole or in pieces made no difference. The Indiana Station(Bul. 381 by J.Troop) says the half piece gave better results that the whole piece.

Along with the discussion of whole vs seed pieces, there has been carried on a discussion of size of seed. Again there may be a chance for any one of a number of things that will make more difference than one can hope to find by a comparison of the results between whole potatoes and pieces.

Along with the discussion of whole vs. piece seed, there has gone the discussion of the size of the piece. The Mich Bul.93 on size of seed piece found no difference between the large and small, but recommended a piece blocky in shape and weighing about 2 oz. When small potatoes are used as seed, there is always the chance of poorer returns, for while certain small potatoes may produce good potatoes, yet there is always the chance of getting a poor crop of small potatoes.

As is seen from the foregoing discussion the many experiments seem to be more or less conflicting. However, some general principles are as follows:

1. The yield to the acre increases with the size of the fraction of the seed tuber, from one eye up , 50 or more bushels of seed to the acre, when the distance of planting is the same.

2. The yield to the acre increases with the size of the fraction of the seed tuber from one eye up to the whole large tuber.

3. The net yield to the acre above the amount of seed planted and the increased value of seed potatoes kept till spring compared with an equal number of bushels on increased yield which must yet bear the expense of digging, storing, and marketing reduce the size of the most profitable seed to plant to much smaller size.

4. Increasing the number of hills to the acre together with the amount of seed used while keeping the size of the seed constant increases the total yield and reduces the yield of the individual hill and the size of the tubers.

5. Cutting the same weight of seed to an acre into smaller pieces may or may not increase the yield because the seed will at some size be cut too small to insure a good start to the plants.

6. Salable tubers used as seed, usually outyield cull seed, because of the fact that a large portion of the culls come from weak, deseased or degenerate hills.

POINTS FOR JUDGEMENT OF A POTATO.

1. High yield.
2. Good quality.
3. Desease resisting capabilities.
4. Good keeping qualities.
5. Good color of flesh and skin.
6. Skin of desirable texture.
7. Tubers of good shape.
8. Shallow eyes, relatively few in number.
9. Maturing in season common to the variety.
10. Upright vigorous plants.
11. Heavy leaf cuticle.
12. No tendency to make second growth.
13. Trueness to type of variety grown.

If the above mentioned points are to be the test of the potato, then what has been done and is being done to produce a potato of this character? There have been two forces at work developing the potato from the wild plant that was known, to the one we have today. These forces are environment and heredity. Environment in the case of the potato, consists in the soil, rainfall, sunshine, weeds, cultivation, and all other influences similar to the ones mentioned that go to make up the new plant. By heredity we mean that property of an organism by which its peculiar nature is transmitted to its descendants. Just how much each of these two forces had to do in the development of the potato, no one may ever know.

If heredity has been the main influence , then the potato must have been a plant somewhat like we have today. On the other hand if the change has come about by environment, then all the care man has bestowed upon the potato has been more or less accumulated and that has given us our important food plant. While we may never be able to tell which has been more potent in shaping the course of the potato, we know full well it will respond readily to careful selection.

When we want to produce a new plant or make some changes in what we have we cross one plant with another of a different strain or variety. With any plant this is more or less difficult for the inexperienced workman, and this is particularly true of the potato, for many of the blossoms are imperfect. The seedmen and experiment station men must be depended upon for this work.

On the other hand selection may be utilized by any practical potato grower. Indeed he can ill afford not to use it for the returns are usually so that the grower is well paid for the time.

Selection is a process by which certain strains are eliminated, and the best strains isolated.

The use of the system of field seed selection to find the strain having the greatest inherited vigor with seed plots to multiply the selected seed produces a stock of which the small potatoes may be saved for seed. The hill selection can be carried out easily when harvesting the crop. By following up this selection in a few years good results can be secured.

Ward has conducted at the Ohio Experiment Station a series of experiments for the purpose of securing data to throw more light on the question of hill selection in potatoes. In this work starting with the same original lot of tubers, three strains were grown as follows: (1) seed from high yielding hills; (2) seed from low yield-

ing hills; (3) unselected seed. The following table gives the summary of the results that were obtained from high yielding hills and from low yielding hills.

Source of Seed	Yield of 100 hills				No.tubers in 100 hills.			
	1904	1905	1906	Total Av.	1904	1905	1906	Total Av.of all
	Lbs.	Lbs.	Lbs.					
High yield hills	125	173	116	138	781	865	676	774
Check rows	115	136	79	110	713	630	479	607
Low yield hills	84	75	61	73	566	546	364	492

H.J.Webber in BuL. 257, Cornell University, has devised a plan which is quite elaborate. It seems to have worked well but the grower could not well use it. We much prefer the tuber unit method. In this method, a tuber is cut lengthwise in four pieces, so that a part of the seed end will be in each piece. The four pieces are planted in consecutive hills, and these form the unit. A lot of 200 tubers is planted in this manner. At harvest time each unit is dug separately. Then the difference can be seen. Some runts will yield much more than others. From one similar test there was found a difference of 25 bushels per acre to 320 bushels. The lesson seems to be apparent.

TEST OF TRANSMISSION.

Naturally the question arises whether or not this good yielding quality can be transmitted to the next generation. This question can be answered by referring to some work started by Dr.H.J.Webber and carried on by C.H.Meyers of Cornell. After five years it was found that the low-yielding strain produced 82 bushels per acre, while

the high yielding strain gave 208 bushels per acre. The yield is not the only variation found, for there was a variation in shape of tuber and depth of eyes, as well as in color of skin. It seems therefore to be practical for a grower to practice seed selection.

Along with the selection for desirable potatoes as to yielding qualities, there has been considerable work done for disease resistance. While there has been some progress made along this line, it hardly seems that any firm should advertise any variety of potatoes that is blight proof or disease proof to any other malady.

BREEDING AND SELECTION BY VARIATION.

A bud sport is a case in which a bud or a group of buds on the same plant will give rise to a plant unlike any others of the variety. Darwin reports three instances of this. A tuber of the purple variety, "40 Fold", had a single eye that was white. When it was planted it gave a white variety. The same variety in another instance gave a white tuber which bred true. The white variety, Kemp, sported and gave red, Taylor's fourty-fold. Furwith reports a case where a yellow tuber gave rise to a violet skinned one, Such bud sports are not limited to the tuber character, but many people believe it is also possible that the habit of vine, product, and vigor may also be affected by sporting. It is thru sporting, or selection, or breeding or by the effect of all that a potato resistant to disease may be secured.

CULTIVATION.

Too often the preparation of the seed bed is only partly done before the crop is planted. The farmer who merely grows some potatoes, hopes to finish the preparation after the crop is planted and is growing. To complete this work deep and close cultivation is practiced. It is no uncommon case to find farmers, who do mixed farming, planting potatoes in a field that had been intended for corn or oats. The season had been late or for some cause or other the crop was not gotten in and hence potatoes were planted instead. Potatoes were resorted to , not because the soil was particularly suited for the crop, nor prepared for the crop, butmerely because it was time enough yet to plant potatoes.

In such a case it is quite necessary in all probability that the soil receives other treatment than it had received for the intended crop. It is in this case deep and close cultivation will be resorted to.

Among those who grow a few more potatoes than they need, there are those who feel in order to help the plant, the soil must be thrown up against the plant, as tho the plant will be benefitted by the fresh soil. These persons either do not know or else do not think that the only part of the plant that can take nourishment from the soil is the roots. Hence any care intended for the plant should be directed in that manner . The real effect of the cultivation given is often just the reverse. Too often it prunes the roots and causes an unbalanced condition between the roots and the upper part of the plant.

The writer has been asked many times how often potatoes should be cultivated. As with so many things, the answer is, "that depends". The nearest any general rule is, cultivate often enough

to keep the potatoes clean of all weeds, and often enough to prevent evaporation- to keep a crust from forming.

It is far better to do the preparing of the soil before planting,and give a number of cultivations before the plants peep thru the ground. This will to a measure prevent the weed nuisance and besides cultivation at this time is far cheaper than after the potatoes are up, for at this time a harrow can be used and cheaper labor employed than when a narrow cultivation is used and the rows must be run between. It requires a good man to cultivate potatoes correctly. It is quite true that the only deep and close cultivation be given just when the roots are beginning to form. Then each cultivation after this should be less near and shallower.

In the minds of the older farmers there is still the idea that a potato vine must be"hilled up". When they are asked why this is done, they give no real reason. The fact is there is no reason. The hilling of potatoes should be the exception and level cultivation the rule. In wet localities and in cool climates hilling is often beneficial, but in all other cases level cultivation should be practiced.

HARVESTING.

The time of harvesting the crop depends upon the purpose for which the crop is grown. Where the early market is catered to it seems best to harvest the crop before it is mature. The grower figures that the loss due to premature harvesting is more than offset by the price he receives for his crop. There never has been an instance where the actual loss due to early harvesting was determined. However, there are certain sections that still cater to the early market and believe it is a good practice.

When the potato is grown to be used thruout the winter and spring, it is necessary that the tuber be mature when harvested, for the immature potato loses a great deal more weight and is far less salable than when it is put on the market in a good firm condition.

There are two methods by which potatoes are harvested. The one is by hand and the other is by machinery. It is said more potatoes are harvested by hand than by machinery. However this may be, during the last few years, there have been put upon the market many good potato machines. A more detailed discussion will be found under the subject of potato machinery.

MARKETING

Potato Market at Elmer, N. J.

It is always a question whether the potato crop should be sold in the fall from the fields or be held till later in the season. From a series of years it seems that the price in the spring is not high enough to offset the extra charges caused by holding them till spring. However, the buyers cannot handle the whole crop in the fall, and hence a part of the crop is held till spring. In certain years the price has been so much higher in the spring that it would have paid to have held the crop till spring. This season, fall of 1917, the crop is being held due to the price offered last spring.

There are two distinct types of market. These are the wholesale and the retail. The first is handled by commission men and is generally sold in bulk. Where conditions permit this is by far the most satisfactory method. The writer has had the pleasure and also the worry of getting persons not having a car load, to ship with one or more so that the crop may be shipped in car load lots.

There is always the trouble of getting men to agree on grading as closely as should be done.

This move of cooperative shipping is the beginning of a cooperative growers association. As a rule each man has his own favorite variety and feels it is the best no matter what the market demands. Where the doctrine of one variety has been successfully preached, and when men appreciate the value of grading, a long stride has been made toward either a cooperative shipping association or a potato growers association. In many parts of the United States there are successful potato growers associations, notable in Mich., New Jersey, New York, Maine, Minn. and Virginia.

In contrast with the wholesale market there is the semi and the local market. In the local market the farmer generally sells directly to the consumer either at a market or else along the street by a house to house canvas. This method has several advantages, such as the grower can become acquainted with his customers, and can depend on a definite amount of trade, besides cutting out any profit that may otherwise go to the so-called middleman. This method can be used only where the crop is grown on a rather small scale.

With the semi-local market system there may be a considerable area grown for it is understood that the person contemplating such a move will locate near a city that will be able to handle a consid erable amount. In this field of marketing the grower establishes a jobber trade. That is he sells directly to the merchants in such amounts and at such times as the merchant desires.

In this method of selling a storage is necessary. This storage need not necessarily be expensive. In these days of concrete, a man who is not a skilled workman can do the work. The

writer has seen potatoes kept in a storage in Northern Minnesota till late in June, and the potatoes came out in first class condition. In that particular storage the loss due to evaporation was by no means 10%. The storage referred to was merely a cave dug into the bank and built up within with cedar. Often the top was covered over with earth and sod had formed over it. There are generally two doors so that the cold air cannot enter directly. While the temperature falls as low as 60° below zero, yet these cellars do not freeze. Of course in places where the crop is handled as is done by the potato elevator, or by potato growers associations, there is generally some form of a potato house. North Dakota, Bul.111, deals with the subject of potato store houses.

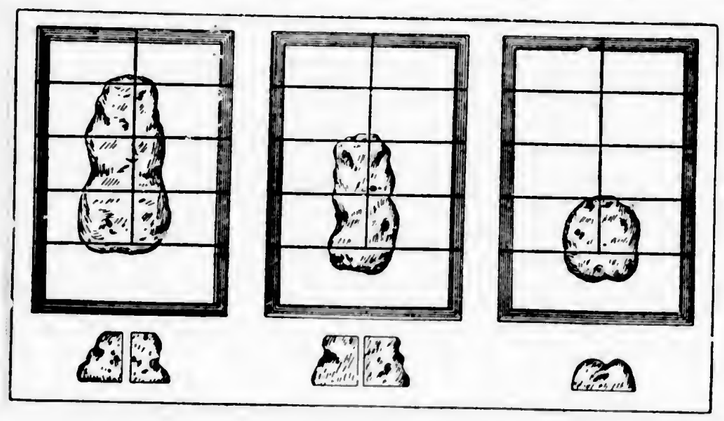
In certain parts of the country where potato growing is the industry, there are found potato elevators. They are conducted somewhat as are the grain elevators. In storing potatoes, there are three essentials necessary. They are: a room where the temperature can be held at about 38° F; should be dark; should be moist enough so that the potatoes will notshrivel. With these requisites the potato can be kept thruout the year, if they are put in storage in good condition. They must be free from all injuries.

By virtue of the many cities, towns, and villages, in Pennsylvania, there are more and better opportunities in Pennsylvania than in any other state. It is estimated that each person consumes an average of 3-1/3 bushels of potatoes each year. In this case it is easy to see that this state does not produce enough for her own consumption, and hence must rely on potatoes from other states. Up until a year or two ago, it was not uncommon to find potatoes from other countries on our markets as far west as Chicago.

It seems that there are many, perhaps small areas, near the centers of consumption that would make good propositions for a lucrative business growing potatoes.

POTATO MACHINERY.

As potato growing became an industry, machinery was needed to make it possible to grow them cheaply enough to be sold for food. In response to this demand, there has been put upon the market from time to time machines to handle the potato from the time it is cut till it is put in storage. The first of these is the potato cutter.



O. K. Champion Potato Cutter in Operation

This machine is of several makes and each company has some peculiar idea that they feel makestheir machine a little superior to the other makes. However, the principle in all is somewhat the same. The accompanying photograph will illustrate one type which is fairly succesful .

POTATO PLANTER

There are two distinct types of potato planters. The first one requires but a single man to plant potatoes, while the second requires two men. The two machines can well be called the "One Man" and the "Two Man" machines.

There are advantages to both, but it seems the virtues of the one over the other are counter balanced by its defects.

No. 25 Planter on W. B. Whitaker farm, Presque Isle, Maine

CULTIVATING MACHINERY.

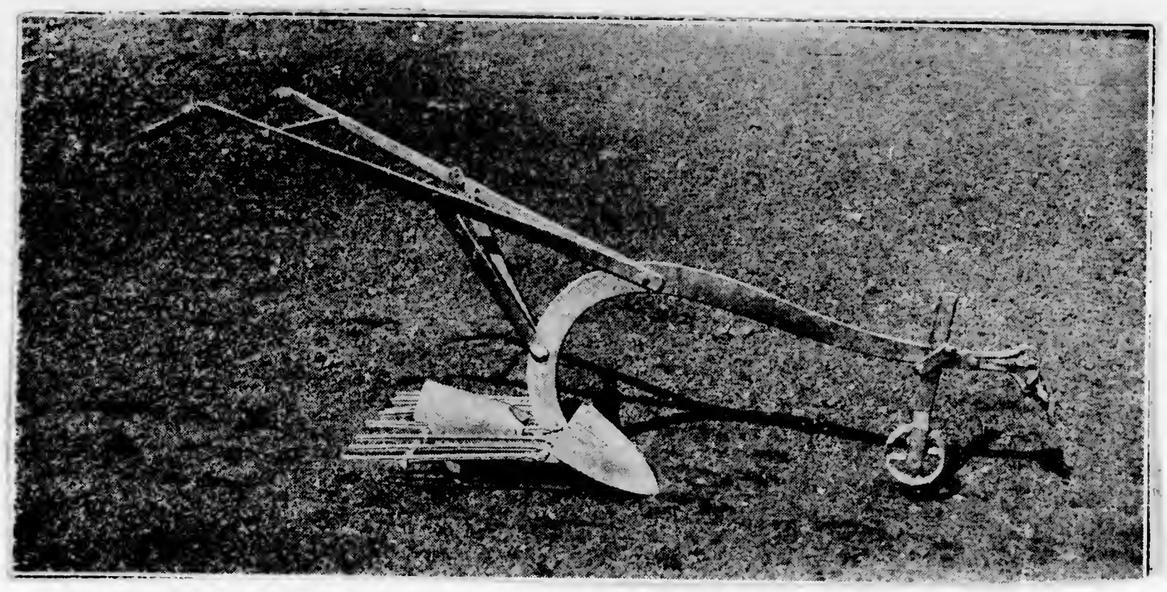
Of the cultivating machinery there are two distinct types with several modifications of each. The first type is the walking cultivator used by those who do not grow any large amount of potatoes. The second is the riding cultivator used by more extensive growers. Besides there is the hilling plow used in some localities as well as the weeder that is used by some growers.

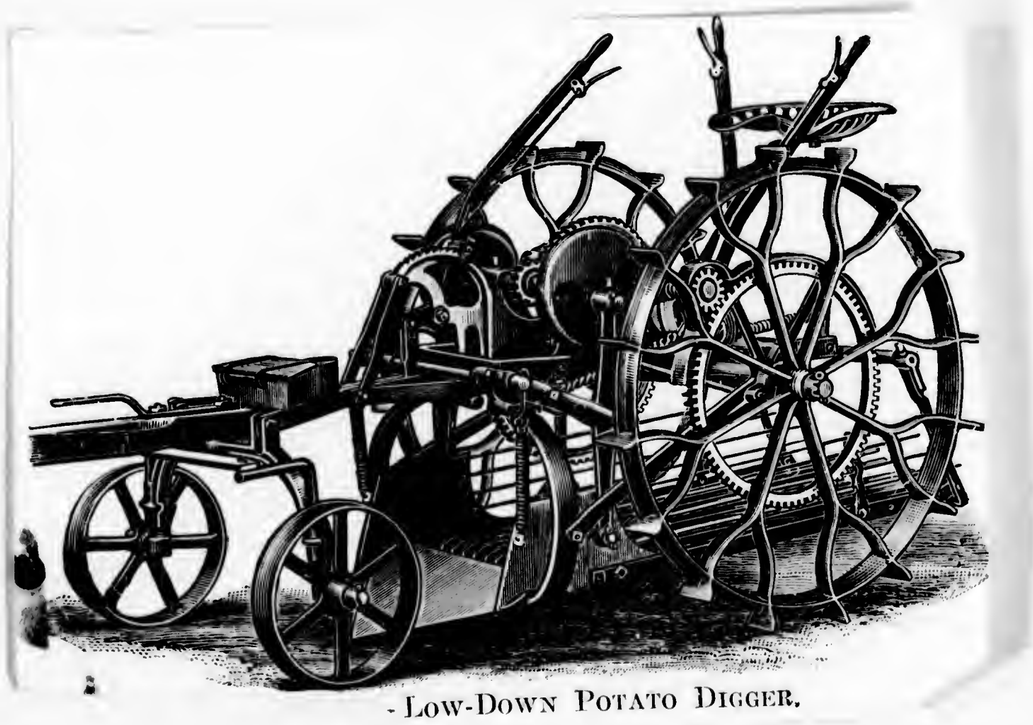
FIG. 214.— LOW WHEEL RIDING CULTIVATOR.

POTATO DIGGER.

The evolution of the potato digger has been something over the order of the development of other machinery. Usually there is some hand tool, such as the hoe for digging potatoes, then comes some horse power machine. The order in the evolution of the potato harvesting machine has been something as follows:- The hoe, the potato fork, the potato plow, the potato digger in all its forms.

The pictures shown on the next sheet will illustrate the machinery.

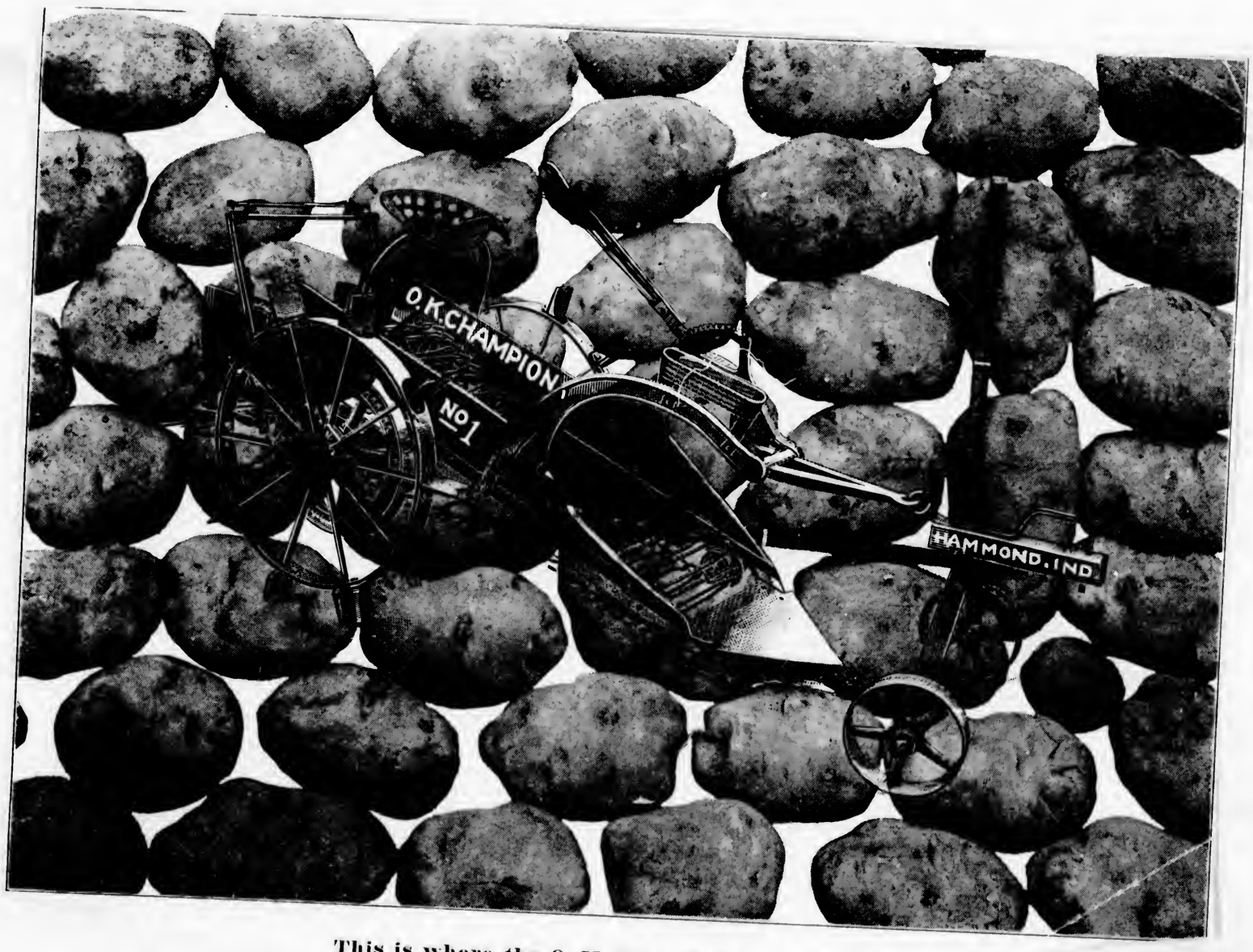




LOW-DOWN POTATO DIGGER.

There are two types of diggers as shown by the pictures on the preceding page. The one is the low-down and the other is the elevated. There are a number of models of each as made by the respective manufacturers. With some machines the potatoes fall directly to the ground, while with others they are better separated and fall in a more narrow row or are even carried into crates or into iron boxes where they are dumped into piles on the ground.

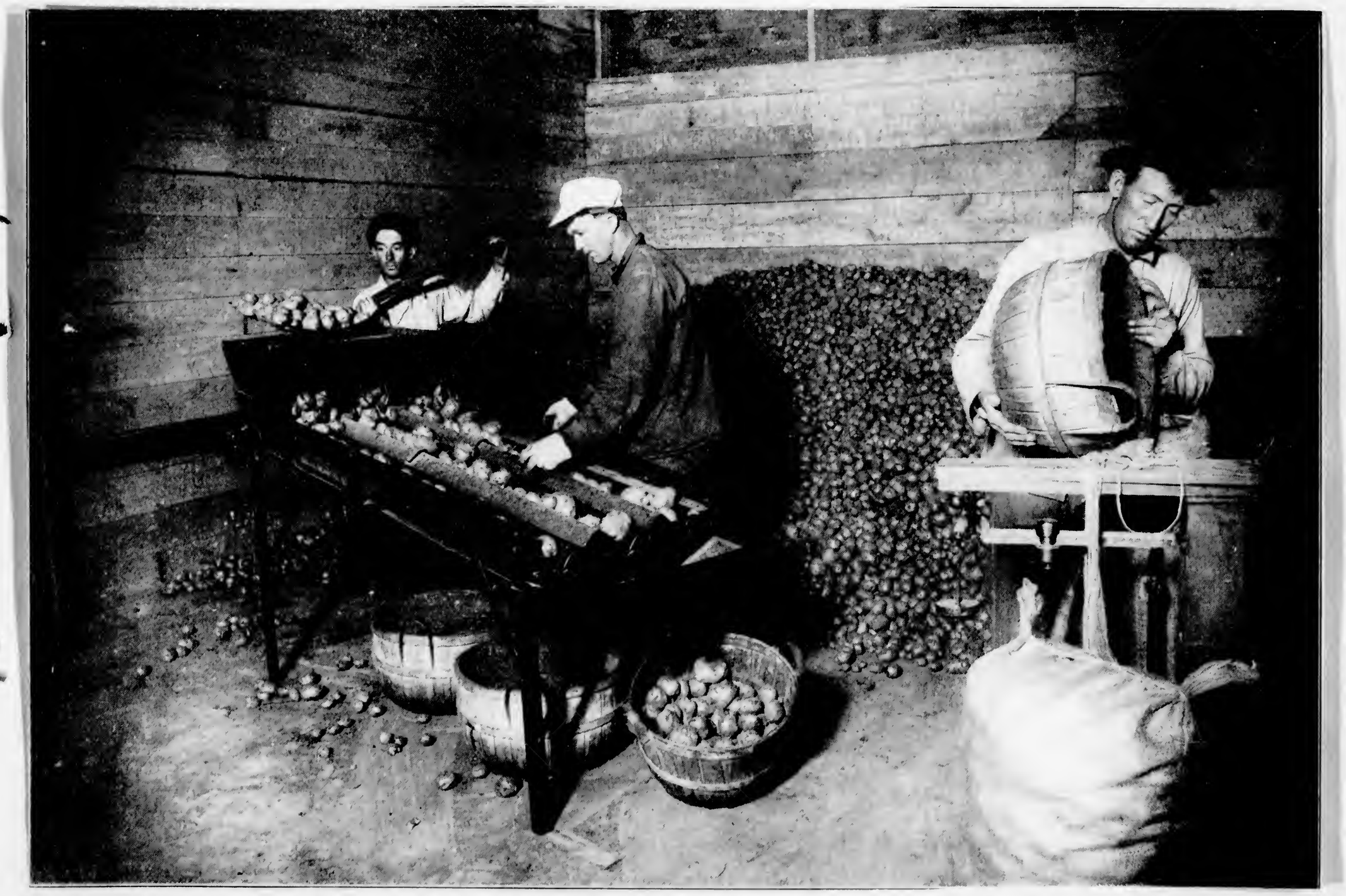
The test of the machine is the work it will do. Many machines that do good work when the soil is dry will do poor work when the potatoes are planted deeply or when the soil is wet. The best rule is, "Try before buying".

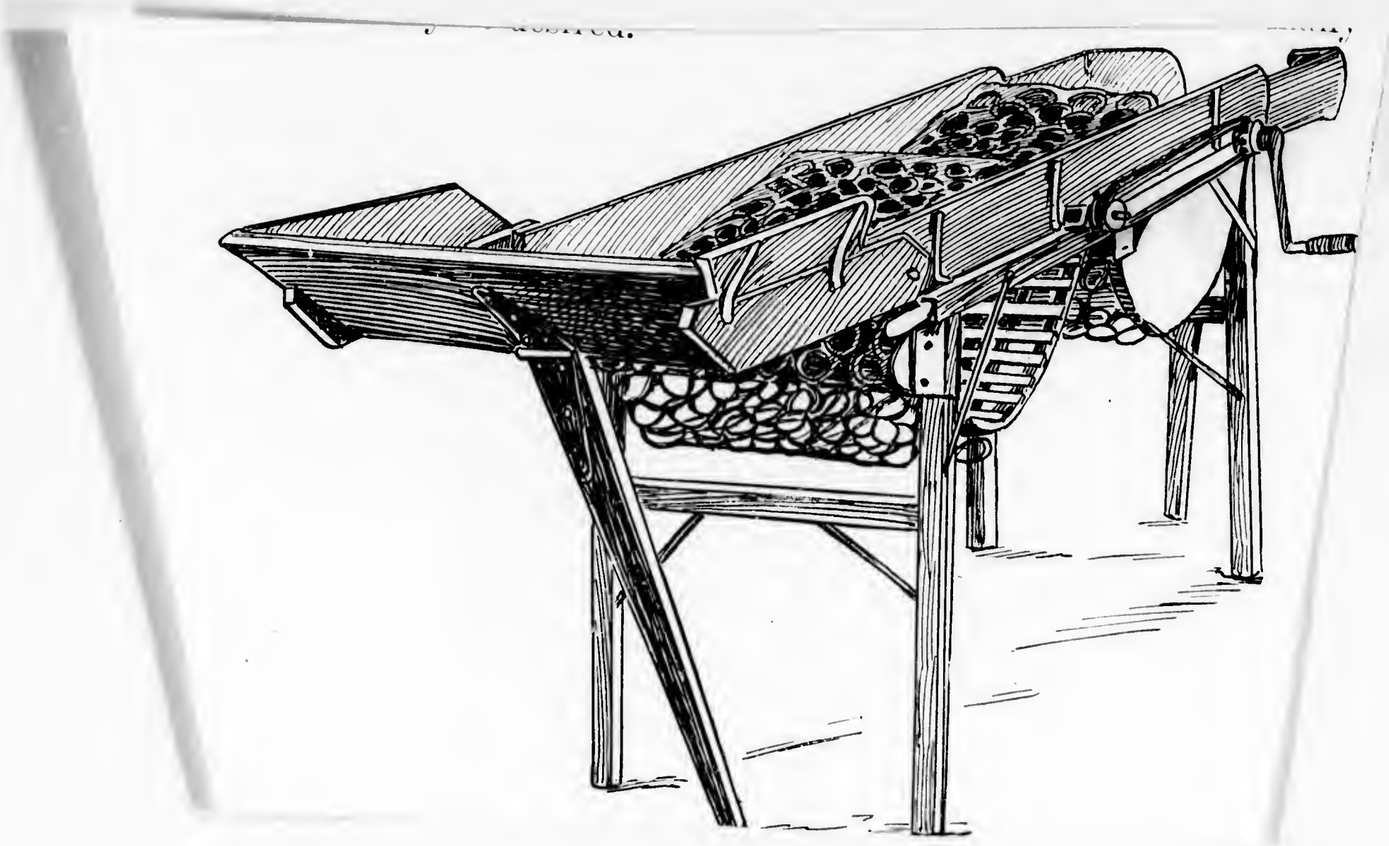


This is where the O. K. Champion No. 1 shines

POTATO GRADERS.

As the market demands a certain size of potato, the commercial grower certainly must cater to this demand, or else lose the trade. To meet the situation the potato grader or better called sizer, was perfected. Again, as in all the other special machinery there are several kinds. The following pictures, on this and the following sheet, will illustrate the different types. The use of a grader is quite necessary.





SPRAYING MACHINERY.

The macine best to use for spraying potatoes depends upon the acreage. When a grower has ten acres or more, then a power machine is necessary and will pay. However, when a less area is used, then some smaller type is necessary on account of the initial expense.

For gardens and fields of less than an acre a four gallon compressed air sprayer or a knapsack sprayer is the proper thing. On fields of a few acres one may use a spray pump mounted in a barrel which is drawn thru the field in a light wagon. The pump should be supplied with two long leads of hose. It requires three men with this outfit, and hence is expensive but the thoroughness of the work repays for the extra expense.

The picture on the next sheet illustrates a good and a poor horse power spray. New York Bul. 57.

FIG. 208.— SPRAYING POTATOES WITH A KNAPSACK

Insects Affecting the Tubers

There are but three important insects affecting the tubers. The first of these is the white grub, the larvae of the June bug, or May beetle. Since this bug lays its eggs in sod, the larvae naturally spends its time there up till and including the pupation period. It requires two summers in the ground for it to mature. From this fact, no piece of land should be planted to potatoes, when it has been in sod one year.

The second pest affecting the tubers is the mole cricket. This creature does not as a rule do a great deal of harm.

The third pest to be considered is the wire worm, the larvae of the chick beetle. These larvae in sod, develop in the ground and require from three to five years to complete their life cycle.

WIRE WORM

While the larvae mature in the fall yet they do not come out of the soil till spring. It has been found by early fall plowing and harrowing and by using a crop such as buckwheat, a crop upon which they do not feed much, will help eliminate this pest.

The tuber moth is a serious menace to potato growing in California, but as far as the writer knows it has not been found in the eastern part of the United States.

FUNGUS DESEASES.

Early Blight (Alternari solani)

Of the fungus diseases best known and perhaps of most economical importance are the early blight and the late blight. While these names are not the best, they seem to have become more or less common and will perhaps remain as the names of these two diseases. The early blight is caused by the fungus, Alternari solani. It appears as angular spots on the leaves, which may become so numerous as to kill the plant. The vines usually do not become infected until after blossoming time. As this is the critical period in the life of the plant, for the blossoms require considerable effort on the part of the plant as well as the tubers that are now forming, it is quite necessary that precautions be taken to prevent the drain by the disease. This disease can be controlled or largely prevented by proper and timely applications of Bordeaux-4-4-50.

LATE BLIGHT.

Just along with the early blight should come a discussion of the last blight, for while the terms early and late are applied to these diseases they do not by any means tell anything as to the time of attack. The late blight does not appear each year but may appear one year and not occur for several years, while on the other hand there may be an outbreak the following year. Much depends on the weather.

The disease appears on the leaves in irregular shaped forms, and spreads thruout the plant, and will kill the entire plant. Besides it will affect the tuber, and cause first water spots on the upper surface. When the tuber is cut open, it shows the rot to extend from the surface. When the potato is attacked and the weather is moist there is an unpleasant odor given off peculiar to the disease.

The control of the disease must be done in part before the crop is planted, for it often happens that a diseased tuber is planted and as the young plant begins to grow the disease also starts and thus makes its appearance the next season.

When clean seed is planted and proper spraying is carried out, late blight can be controlled. Where spraying has been neglected, the writer has seen the entire crop destroyed.

The pictures on the next sheet illustrate the appearance of this disease.

FIG. 195.—POTATO PLANT ATTACKED BY LATE BLIGHT.

Fig. 2. Tuber, affected with Late Blight, cut in half.

FUSARIUM WILT.

The cause of this disease is a fungus fusarium oxysporium, which gains entrance thru the roots from infected tubers or from the soil, and works upward in the sap vessels, thus interfering with the circulation. The mycelium of the fungus destroys the roots and later fruits on them, producing many spores. The diseased condition of the roots cause a yellowing, a dwarfing, and finally a wilting of the vine.

The stem pulls up easily and the tissues beneath the outer layer show a brownish color. This color extends to the roots, stolons and tubers. A cross section of a diseased tuber will show brown areas .

Such tubers should never be used for seed purposes, for vines coming from these tubers nearly always become infected. Tubers should be selected from healthy plants.

Fig. 10. Cut stem end of a potato affected with Fusarium Wilt.

VERTICELLIUM WILT.

This disease is very similar to the Fusarium wilt. Since the control is similar there need be no further discussion concerning the disease.

BACTERIAL DISEASES.

Potato scab is perhaps the best known and the most common disease among the bacterial diseases. It is caused by an organism known as Actinomyces Cromogenus. It effects only the outer layers while a scab caused by insects penetrates the surface.

The organism lives thru the winter either on the tuber or else in the ground. It has been found that parings thrown on the manure heap will retain the organism in a healthy condition and when hauled to the field will re-infect tubers even tho clean seed be planted on clean soil.

It is easily seen why a good rotation of crops should be practised. This with using clean seed, treated for scab, will pretty well prevent the scab.

Fig. 7. Deep scab due to mites.

WART AND SILVER SCURF.

The potato wart is caused by a lower form of fungi, called Synchitrium endobioticium. This organism causes the tuber to become a wart-like growth. As far as is known the disease is not known in the United States.

SILVER SCURF.

The disease known as silver scurf is caused by the organism, Spoudylocladium atrovirens, recently introduced from Europe, and has been observed in the United States. The tuber shows spots having a silvery lustre, from which the disease gets its common name. The disease causes the tuber to shrivel due to the loss of water by evaporation.

Seed treatment as yet does not seem effective. If the field is clean, be sure to plant clean seed.

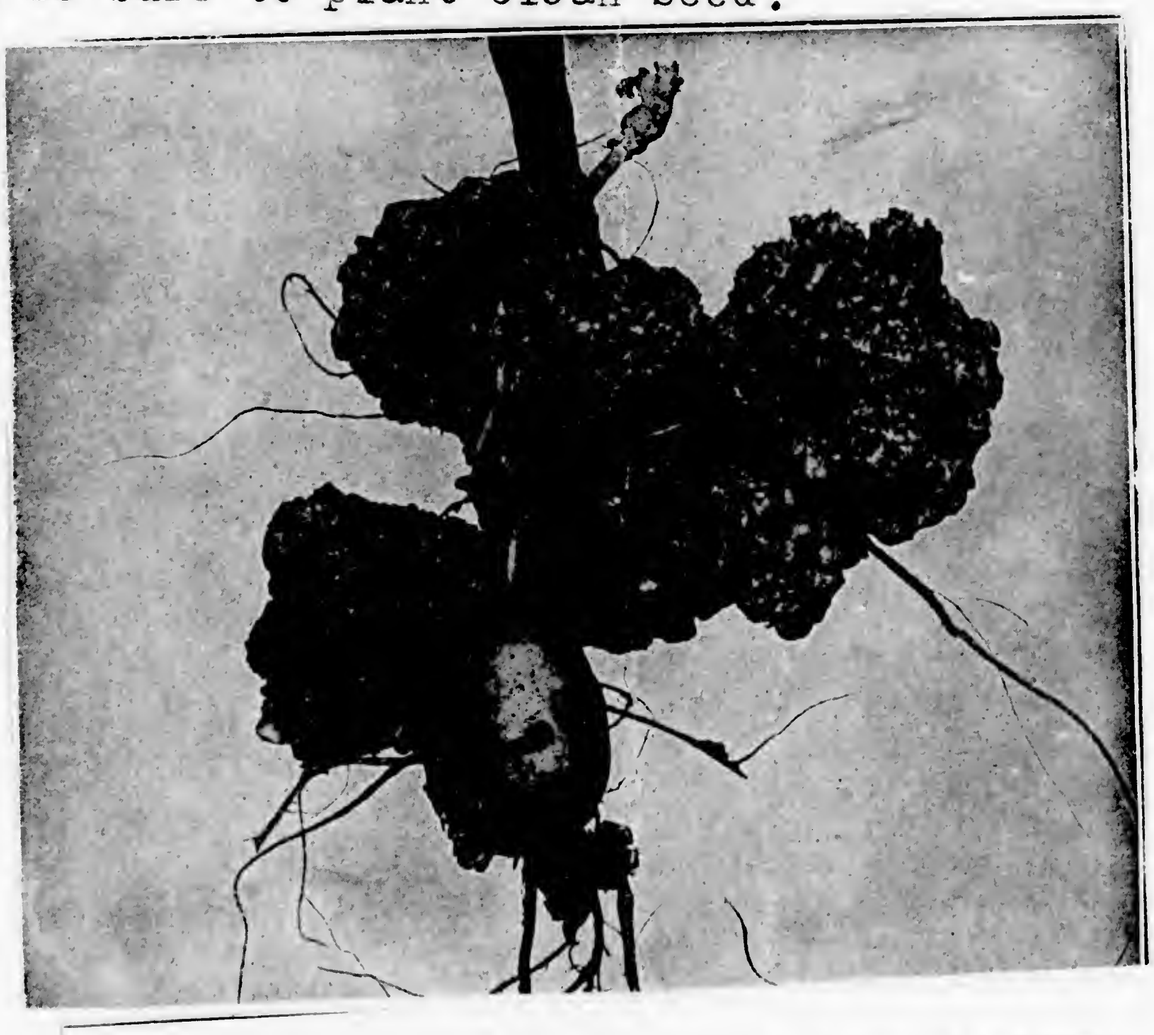


Fig. 11. The Wart disease of potato. From U. S. Dept. of Agriculture.

POWDERY SCAB.

This disease as far as is known to the writer is not found in the United States. Very little seems to be known about it, except as it appears on the tubers in a form similar to the common scab. The accompanying illustration shows pretty well the appearance of the disease.

Powdery Scab of Potato (tuber from Canada).

FUSARIUM DRY ROT.

The rot caused by species of Fusarium is a dry rot extending deep into the tuber. The surface of the rotted area is much wrinkled and often shows numerous clusters of a white moldy growth. The fungus gains entrance to the tuber thru wounds in the skin, or by lesions caused by other fungi, so there is no one point on the tuber where the rot may start. None of the dry rots are known to attack the vine but the disease is known to be able to live over winter and may attack and infect the new crop. A rotation of crops and only planting only clean seed will aid materially to hold this disease in check.

RHIZOCTONIA OR SCURF.

This disease is by no means peculiar to the potato for it has been found that much of the damping off of young seedlings is due to this fungus. The disease appears on the potato as little black spots that one might mistake for particles of earth. They are really small masses of mycelium. Prof. G.H.Coons of the Michigan Agricultural college conducted an experiment in which he selected some apparently clean seed, some which showed the disease, and some which was treated with formalin. The results were:-

Clean seed gave 5.7% diseased tubers; treated seed gave 50% diseased tubers; Infected seed gave 57% diseased tubers.

As the grain crops are seemingly not attacked by this disease, a wide rotation would seem beneficial, together with selected seed.

Rhizoctonia, or Scurf, showing sclerotia upon the potato. Enlarged four

VARIETIES TO GROW

When one is expecting to grow potatoes he naturally wants to know what varieties are best for him to grow. Unless one is acquainted with the conditions he could give no very satisfactory snswer. Very much depends on the use to be made of the crop. When the crop is to be put on the market as early potatoes, then either the Early Ohio and the Irish Cobbler are the ones best suited for this purpose.

Where the varieties are to be grown for a late crop then some standard variety should be grown. Just here it is well to again mention the fact that only one variety should be grown. Perhaps it would be better to say a group of varieties. The point is that a round potato will not sell well when mixed with long tubers. The two important groups are the Rural or blue sprouts and the Green Mountain or green sprouts. Of the two, the first is the more important. It is largely a matter of local conditions that should determine the group to be grown.

The Green Mountain is of slightly better quality than the Rural, but seems to be better adapted to sections where the rainfall is abundant as in the famous Aroostook County potato growing section. On account of its setting tubers earlier than the Rural, it is more likely to damage by drought than the Rural.

RURALS

The tubers of this group keep well and are late to sprout in the spring. The tuber formation is also delayed and this sometimes helps the tubers to mature. However, when the season has been dry and wet weather follows they are likely to be hollow. The tubers are a good shape, good quality and a good color. The vines develop

UNIVERSITY OF MAINE COLLEGE

somewhat slowly at first but later branch considerably. They are fairly resistant to all diseases except late blight.

There have been many variety tests but there seems to be no one variety that has responded in enough tests to say which variety is best.

VARIETY TEST FROM PENNSYLVANIA STATE COLLEGE.
Variety test covering four years, resulting in selection of varieties in point of yield.

Early variety, 8 varieties tested.

Name	Yield	Total yield	% Work
6 Weeks	132. bu.	152.7 bu.	86.6
Pride of Michigan	127.4 "	170.4 "	74.8
Irish Daisy	129.1 "	148. "	86.7
Mid early , 21 varieties tested			
Early Puritan	183.1	199.7	91.7
Early Rose	175.1	202.7	86.7
Ex.Early Crusader	173.2	203.4	85.1
Uncle Sam	168.6	200.6	84.
Late, 10 varieties tested.			
	180	202.9	88. 7
Ver. Goid Coin	178.5	215.7	82.8
Heath's Late Beauty	171.9	192.7	89.2
Sir Walter Raleigh	170.	210.2	81.4

Soil heavy dry loam, best condition in 4 year rotation of oats, wheat, timothy, and clover, potatoes seed treated for scab, formalin and bi-chloride. Plants 15" x 36" apart 3" deep, 4 or 5 cultivations. For spray we made Bordeaux mixture and paris green. Seems yield was the real point of determination.

POTATO DISEASES.

PESTS.

There are four divisioms of potato insects. For convenience they are sometimes divided as follows:-

1. Insects chewing the leaves.
2. " sucking " "
3. Stalk Borers.
4. Insects affecting the tubers.

Perhaps the most common and best known of all the potato enemies is the Colorado potato beetle. It was not known east of the Rocky Mountains until after 1855. It originally fed on wild plants of the potato family. It seems to have learned that the potato presented better opportunities for feeding than the wild plants. So about 1872 it had reached as far east as New York state. On account of the decreased leaf surface that this creature causes, the plant is not able to carry out its life's work. On account of this condition the tuber may be immature when dug and watery when cooked.

This creature produces two generations a year. The adult beetle spends the winter from 8 to 10 inches under the ground. In spring she emerges and flies about. As soon as the potato is above ground, she begins to feed, and in a little while, to lay eggs on the under side of the leaves. It requires from 4 to 7 days for the eggs to hatch. The larvae really pass thru 4 stages in from 16 to 21 days, depending on the weather. They go into the ground and remain there a week or longer in a resting stage, after which they emerge as mature beetles. The egg laying lasts about 35 to 40 days, and during this time each female lays from 500 to 1000 eggs. The life cycle requires about four weeks. The beetles of the second generation emerge early in Autumn, feed a few weeks and then go into the ground

to hibernate .

By adding an arsenical poison to the Bordeaux, this insect can be controlled. If this is done for the first two applications, generally it need not be done any more, but in case the beetles promise to be troublesome, the remedy can be repeated. One to two pounds of Paris Green or three to five pounds of Arsenate of Lead added to 50 gallons of Bordeaux will answer for bugs.

FLEA BEETLES.

There are several species of beetles, but all have about the same life history. The adult beetles hibernate during the winter, under leaves or rubbish, and in early spring come out and lay their eggs on the roots of the plants, such as the potato. The larvae mine into the roots and, when full grown, they pupate and later emerge as adult flea beetles. There are two or three generations a year.

The time of injury is during the growing of the vine. These tiny creatures eat small round holes in the leaves. Occasionally the larvae do harm by boring into the tubers and causing pimply potatoes.

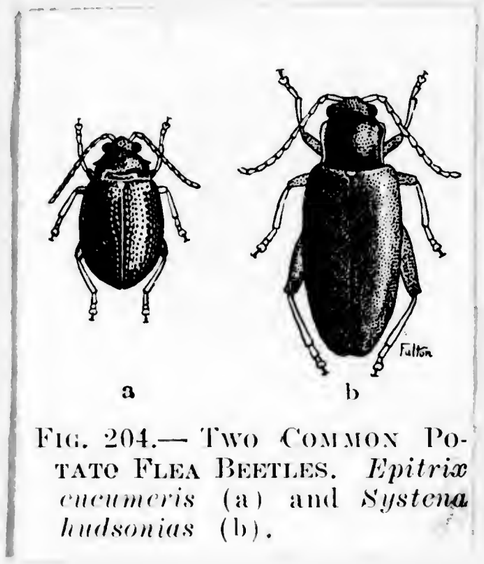
These pests can be controlled partly by the treatment for the Colorado beetle and, if it seems necessary, an application of Bordeaux will be found to answer the purpose. As these insects eat on the under-side of the leaf, the spraying must be done thoroughly.

There are also the blister beetles; the three-lined leaf beetle, and the tortoise beetles. None of these are especially injurious on well-sprayed vines.

Of the insects doing injury by sucking the potato plant louse is the most important, and this only in particular years. They can be killed either by kerosene emulsion, soap, or tobacco extract. There are so many predaceous insects that prey on them, that as a rule

they do not do enough injury to be of any economic importance. The Maine Agricultural Extension Bulletin 147 discussed these creatures.

The potato stalk weevil and the stalk borer are two insects that do harm to the potato stalk. The first one of these bores into the stalks and does considerable damage. The adult of these pests remains in the stalks till spring. Hence to control them the stalks should be burned in the fall. The farm should be rid of plants related to the potato, for it is known these insects will live in plants of this kind.



a b

FIG. 204.— TWO COMMON POTATO FLEA BEETLES. *Epitrix cucumeris* (a) and *Systena hudsonias* (b).

FIG. 196.—THE POTATO FLEA BEETLE AND ITS WORK. UPPER LEAFLETS FROM AN UNSPRAYED PLANT, LOWER ONES FROM A SPRAYED PLANT.

e (Leptinotarsa decimlineat Say.)

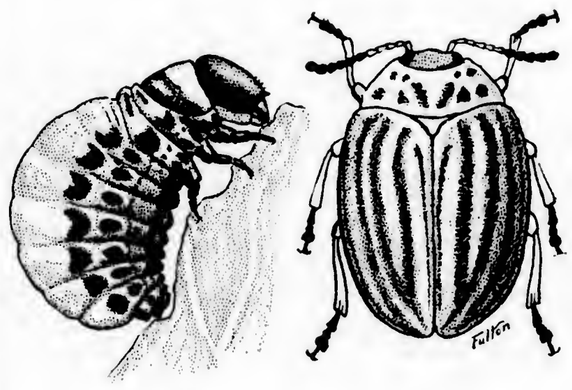


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FIG. 203.— LARVA (A) AND ADULT (B) OF THE COLORADO POTATO-BEETLE.

COST OF PRODUCING POTATOES.

It is an interesting question to find the actual cost of a unit of produce, whether it be in relation to potatoes or any other farm produce. While there is a correct value for all articles, yet that value may or may not equal the cost of production. Of course this year, 1917, is abnormal in many respects, and no fair comparison cane be made. However, during years that are more nearly normal it seems that the following figures from a grower who raises 60 acres a year, might give a fair average.

Five year average.

Year	Yield per Acre	Cost per Acre	Rec'd per Acre	Net Profits per Acre.
1909	166	$59.00	$100.00	$41.00
1910	147	64.00	76.00	12.00
1911	139	67.00	107.00	40.00
1912	169	71.00	121.00	51.00
1913	113	75.00	71.00	4.00
Average	146.8	67.20	93.00	28.00

It has been found that potatoes can be produced for 46 cents per bushel. From the same grower we find his selling price was 63 cents for a five year average. This netted him 17 cents per bushel profit. If this is figured on 46 cents as a base, we find he had a return of 27%. Other growers have given other figures, and therefore a fair estimate can be made by comparing the above figures with other growers.

COST OF PRODUCTION.

Grubb and Gwilford-------- The Potato.

Plowing	$3.00
Harrowing	.75
Float	1.00
Seed for planting	14.00
Planting	2.50
Investment first year	5.00
Cultivated 3 times at 50¢	1.50
Digging	1.30
Picking 150 bu. at 4¢	6.00
Sacks, 75 at 7¢	5.25
Hauling to pitt	2.00
No interest on investment	
	$44.00

----------ooOOOoo----------

From Colorado---- Greeley Commercial Club.

Plowing	2.50
Levelling and Harrowing	1.00
Seed	5.00
Planting	1.50
Cultivation	2.50
Investment	1.50
Digging	7.50
Sacks	7.50
Marketing	6.00
	$35.00

200 to 300 bushels per acre- Average price has been for 10 years, 65¢

COST OF PRODUCTION

Kansas State Board of Agriculture. 32 growers.

Average cost of plowing	$1.20
Harrowing	.54
Seed	7.25
Plant	1.35
Cultivation	1.66
Digging and marketing	8.85
Wear and tare, interest on land, rent of land, interest on investment	25.27
	$46.12

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NEW YORK.

Survey by Department of Farm Management.

New York State College of Agriculture.

	1913	1914
NO. of farms	18	21
" " acres	185.4	158.8
" " " per farm	10.3	7.6
Average yield per acre	102.7	154.7

New York State College.

	Luben County		Clinton and Franklin County	
No. of farms	355		300	
Yield per acre	131		199	
Acres per farm	14.7		7.2	
Seed per farm	10.2	9.48	12.	6.79
Fertilizer	120 lbs.	1.66	407. lbs	5.77
Manure	2.3 tons	4.61	3.4 tons	7.21
Spray materials		20	110.4	.22
Man labor	66	11.55	88.6	17.65
Horse labor	68.9	10.33		10.20
Use of equipment		3.45		3.94
Land		3.00		7.00
Buildings		.81		1.56
All other cost		.45		.12
Total cost		45.54		60.68
Same per bushel		.35		.33
Per acre cost to market		5.80		6.32
Per bushel		.054		.044
Profit per acre		2.22		36.72
" " bushel		.02		.21
Profit per man hour	.03			.33

Cost of growing an Acre	Amount	Total	Amount	Total
Seed	10 bu.	7.67	12.6 bu.	8.03
Fertilizer	412 "	5.17		5.72
Manure		6.14		4.64
Spraying		.83		.80
Man Labor	77.7 hrs.	13.30		15.57
Horse "	77.4 "	10.66		12.41
Equipment		3.58		3.71
Land at 6%		4.53		5.18
Buildings at 8%		1.27		1.09
Interest at 5%				.88
All other cost		.03		.04
		$53.74		$58.07
Cost of marketing per bu.		.12		.05
Cost of growing " "		.52		.38
Cost of both		.63		.43
Profit per acre		7.38		16.03
" " bushel		.07		.10
Profit per man hour		.08		.18

A Comparison of Different Farms.

	Dairy	General	Fruit	Potato	Truck	Av.all farms
No. farms	67	60	31	14	6	178
Av. Area	154	134	100	121	47	132
Tilled area	126	113	88	97	37	110
Total crop	10417	11327	12895	11801	6652	11137
Gross Income	2529	2327	12895	11801	6652	11137
Expenses	1318	1130	1651	1207	929	1291
Net income per farm	1211	1197	2852	1911	945	1538
Per acre net income	7.86	8.93	28.52	15.79	20.11	11.65
Net income per tilled acre	9.61	10.59	32.41	19.70	25.54	13.98
Returns on investment	8.7%	7.9%	19.8%	13.7%	9.7%	11.1%

Cornell University-- Warren's Farm Management.

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CONCLUDING REMARKS.

In the way of a conclusion it might be well to call attention to the conditions under which potato growing is a success

1. The climate must be conducive to the growing of the pota to.

2. The soil must be such that a hundred bushels or there about can be grown per acre.

3. There must be market facilities. With these three prerequisites, potato growing can be made a profitable business and is

well suited to be made a part of the farm rotation.

It seems far better to the writer to make the potato one of the principle crops than to make it the only crop of any farm.

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I Have drawn on Bailie's Enc. of Agriculture for the material on the Botany of the potato!

End of Title